

Beyond printing: How to expand 3D applications through postprocessing

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a. Coloring

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My Projects

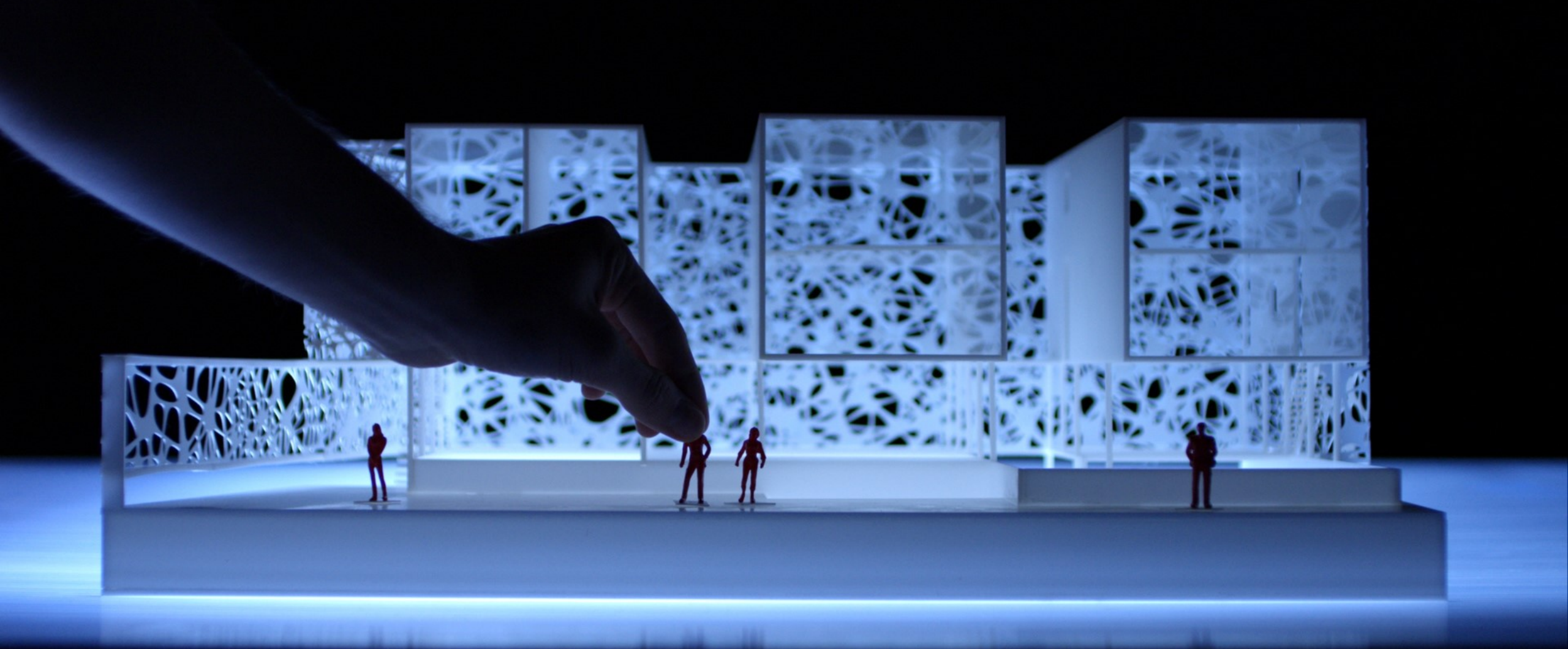
Component 425-804

- Component A25-804
Part 1 of 1
- Component L80-HE7
Part 1 of 1
- Component 204-916
Part 1 of 1
- Component 044-501
Part 1 of 1
- Component L81-913
Part 1 of 1
- Component 886-474
Part 1 of 1
- Component 026-V74
Part 1 of 1

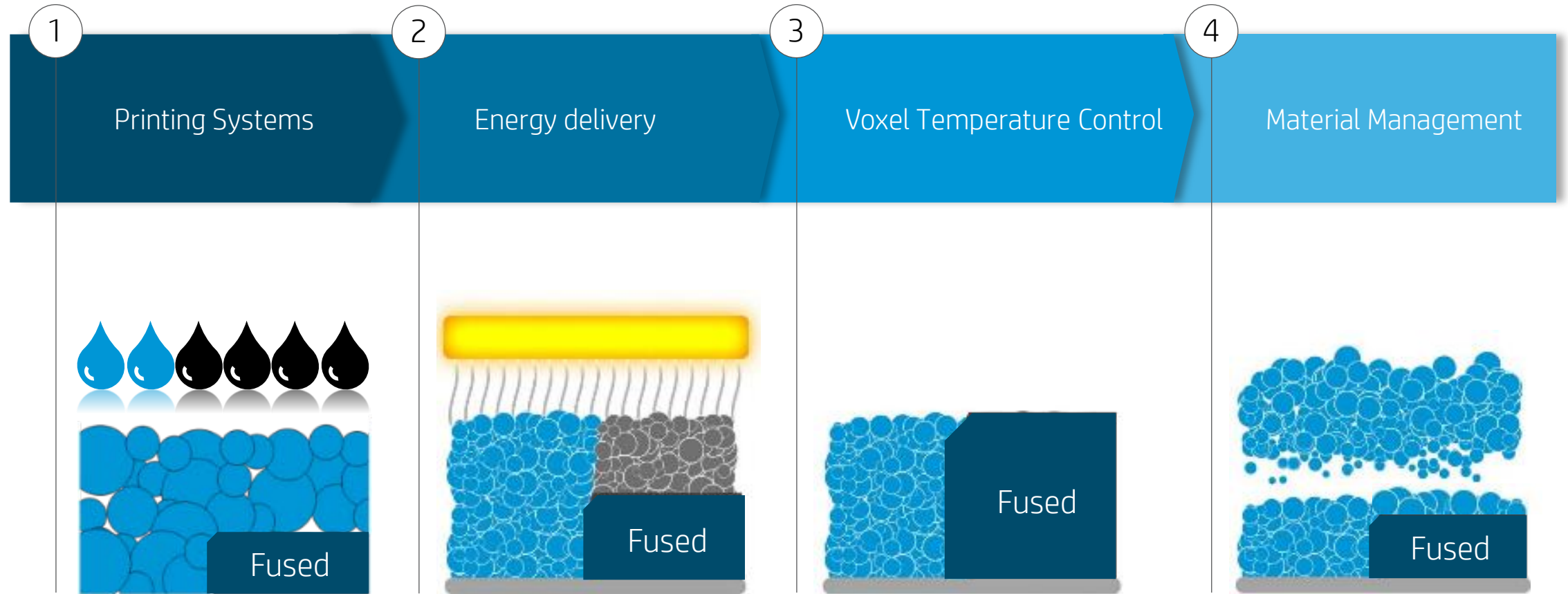
3D CAD model of a pot with various dimensions and annotations.



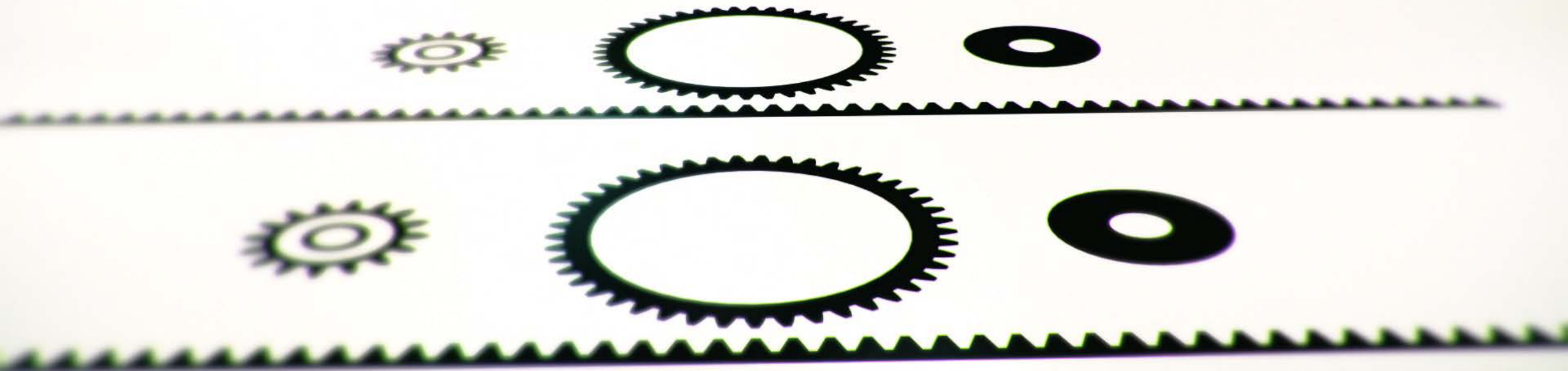
Technology overview



HP Jet Fusion 3D Printing Process



HP Proprietary Multi-Agents



HP Jet Fusion 3D Printing Solution

POST-PROCESSING

Cleaning

Line

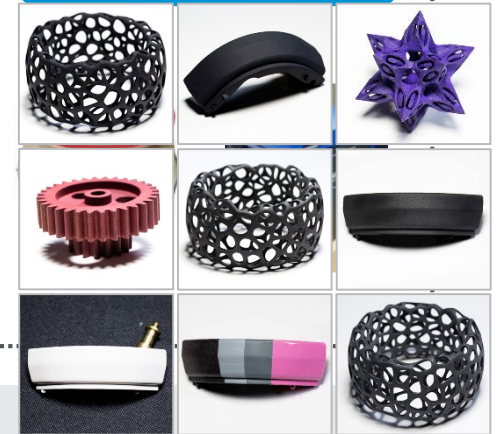
Secondary post-processing



Part with powder



Natural part



Final part

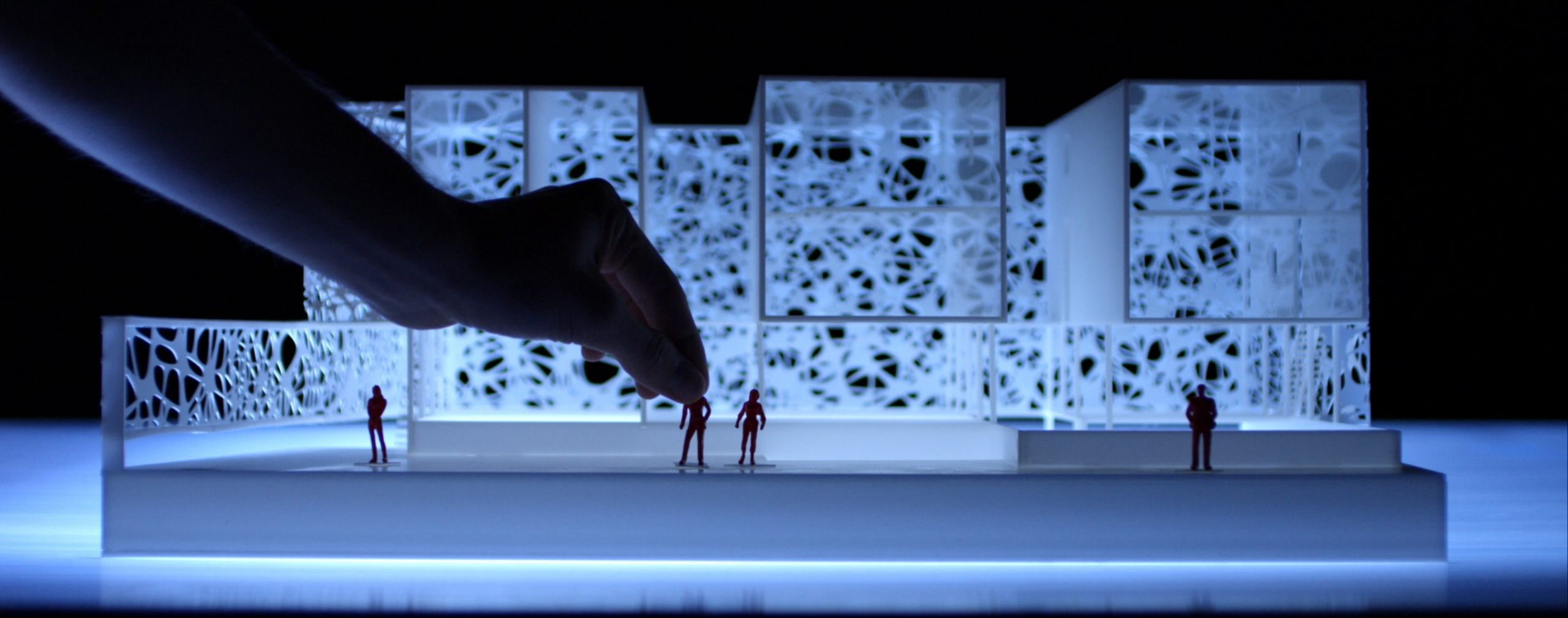
E2E HP Jet Fusion 3D Printing workflow

REQUIRED

OPTIONAL

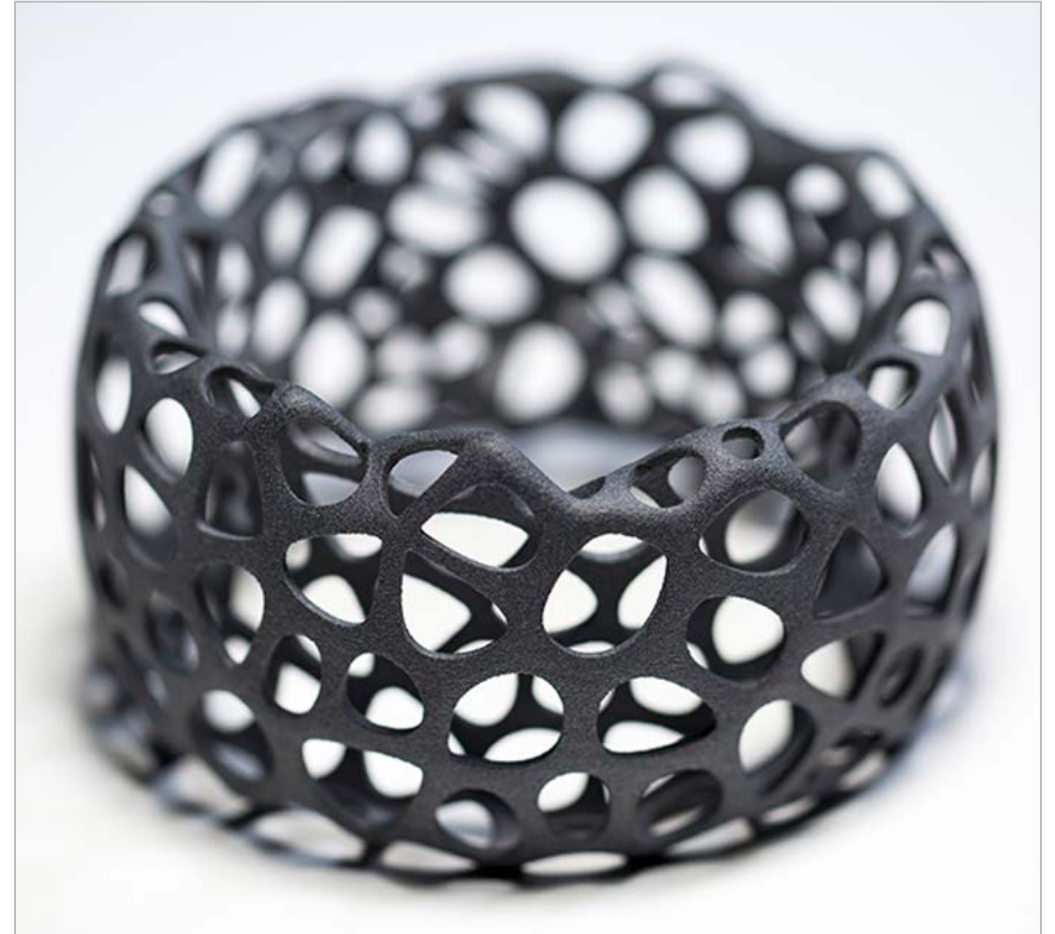


Cleaning



Cleaning

From an unpacked part to a part that's ready to sell



Cleaning

POST-PROCESSING

Cleaning

Secondary post-processing



Part with powder

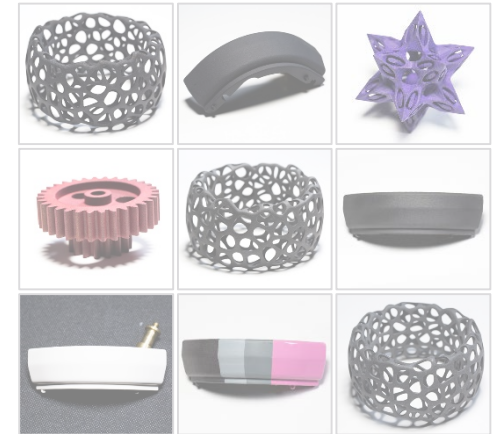


Cleaning

- Bead blasting
- Waterjet blasting



Natural part



Final part

REQUIRED

OPTIONAL

Bead blasting

Different bead blasting solutions

Production workflow

Manual bead blasting



\$3k - \$10k

Process time

Operator time

Machine time



Step 1: Bead blast



Step 2: Air blast

1 min – 10 min per part

30 sec – 5 min

30 sec – 5 min

30 sec – 5 min

30 sec – 5 min

Automatic bead blasting



\$8k - \$30k

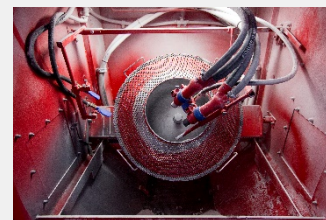
Process time

Operator time

Machine time



Step 1: Place parts



Step 2: Bead blast + air blast



Step 3: Remove parts

20-40 min per batch

< 5 min

< 5 min

< 5 min

10-30 min

< 5 min

Abrasives for blasting

Different abrasives with different properties

Bead blasting

Glass beads

Advantages:

- Low cost
- Results in a nice surface finish
- Can be used to improve surface roughness



Particle size of 70-110 μm

Other metallic abrasive (as stainless steel particles) are more aggressive but improve more the color uniformity.

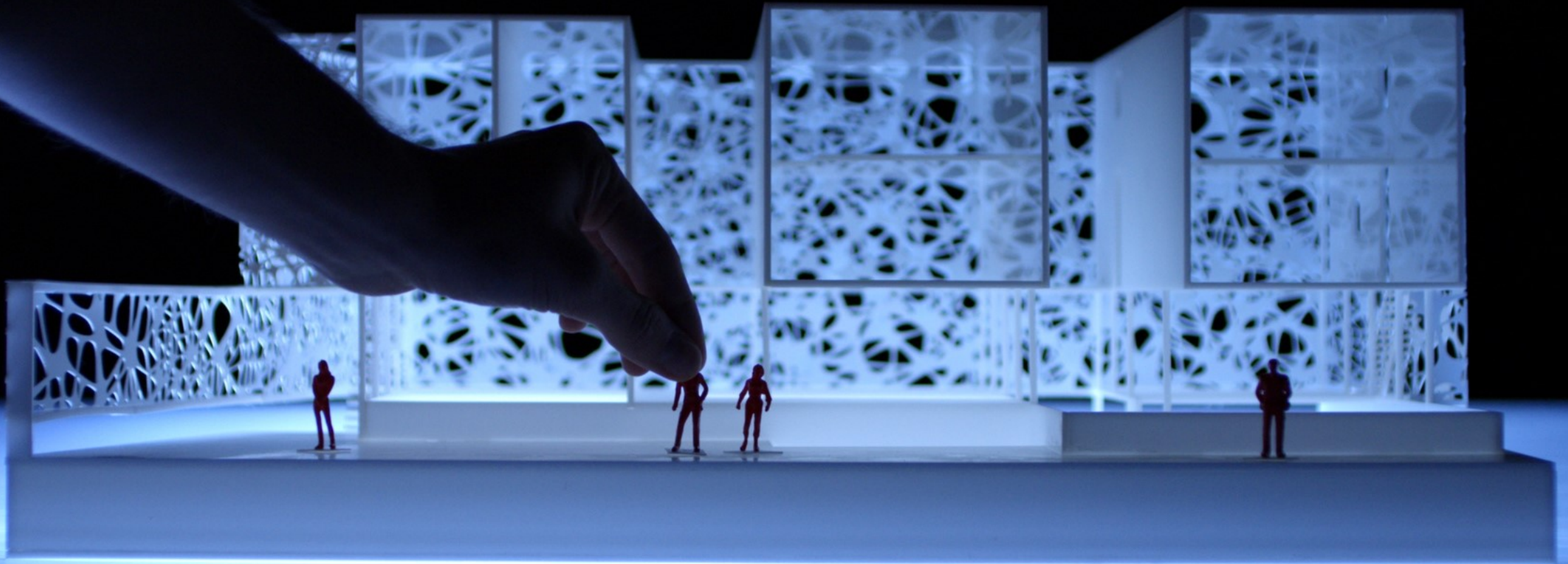
Shot peening

Ceramic abrasive

Advantages:

- Reduces the scratchability of dyed parts
- Can be used to improve surface roughness

Secondary post-processing



Color uniformity

POST-PROCESSING

Cleaning

Secondary post-processing



Part with powder



Raw part



Secondary post-processing options



Final part

REQUIRED

OPTIONAL

Color uniformity

POST-PROCESSING

Cleaning

Secondary post-processing



Part with powder



Raw part

Color Uniformity

- Dyeing
- Graphite blasting

Coloring

- Painting
- Dyeing

Dimensional

- Gluing, bonding, welding
- Inserts
- Drilling, tapping, machining

Surface Roughness

- Mechanical Polishing
- Coating/Painting
- Hand sanding
- Chemical polishing

Other Properties

- Wear resistance
- Conductivity
- Temperature resistance
- Mechanical strength
- Water tightness
- Chemical resistance



Final part

REQUIRED

OPTIONAL

Color Uniformity	Surface Roughness	Other Properties
Coloring		
Dimensional		

Dyeing

Dyeing is one of the easiest solutions for improving color uniformity



Dyeing Applications



Consumer goods



POST-PROCESSING

Cleaning

Secondary post-processing

Black color Uniformity

Surface Roughness

Coloring

Other Properties

Dimensional



Prosthetics



Dyeing

Manual solution

POST-PROCESSING

Cleaning

Secondary post-processing

Black color Uniformity

Surface Roughness

Coloring

Other Properties

Dimensional

Process preparation

Production workflow

Manual dyeing



\$500

▶ Process time



Warm up & prepare
dyeing solution

30 min



Step 1: Place parts
in the fryer

45 min per batch

5 min



100 °C

Step 2: Dyeing
Immersion/Stirring

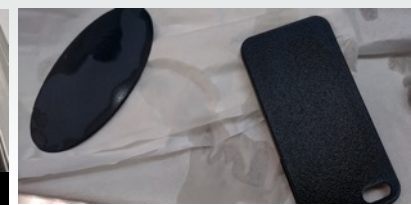
8 min



50-80 °C

Step 3:
Post-bathing

2 min



Step 4: Drying

2-3h (optional)

Girbau 3D Dyeing Solution

Girbau DY 130

A post-processing solution for dye finishing made for HP Jet Fusion 3D 4210/4200 Printing Solutions¹ at a lower cost

Minimum impact on cost per part, as it requires half of the investment compared to other automatic dyeing equipment

Integrate different programs to enable an automatic and unattended process

Dye Working Temperature

60°C

Dye Working Pressure

N/A

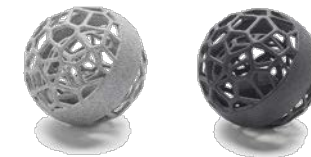
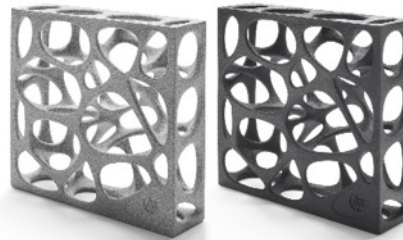
Osmotic Water

None

Cycle Time

2 h

Girbau DY 130 Characteristics



1) HP does not design, manufacture or sell the Girbau product or provide any warranty for the Girbau products. HP believes that the information herein is correct based on the current state of scientific knowledge and as the date of its publication, however, to the maximum extent permitted by law HP EXPRESSLY DISCLAIMS ANY REPRESENTATIONS AND WARRANTIES OF ANY KIND, WHETHER EXPRESS OR IMPLIED, AS TO THE ACCURACY, COMPLETENESS, NON-INFRINGEMENT, MERCHANTABILITY AND/OR FITNESS FOR A PARTICULAR PURPOSE (EVEN IF HP IS AWARE OF SUCH PURPOSE) WITH RESPECT TO ANY INFORMATION PROVIDED. Except to the extent that exclusion is prevented by law, HP shall not be liable for technical or editorial errors or omissions, and damages or losses of any kind or nature that result from the use of or reliance upon this information, which is subject to change without notice. Recipients of the Girbau product are responsible for determining the suitability of Girbau products with HP Jet Fusion 3D products, ensuring compliance with applicable laws and regulations, and being aware that other safety or performance considerations may arise when using, handling or storing the product.



Recommended dye



GTC black liquid dye: 8211C
Provided in liquid state

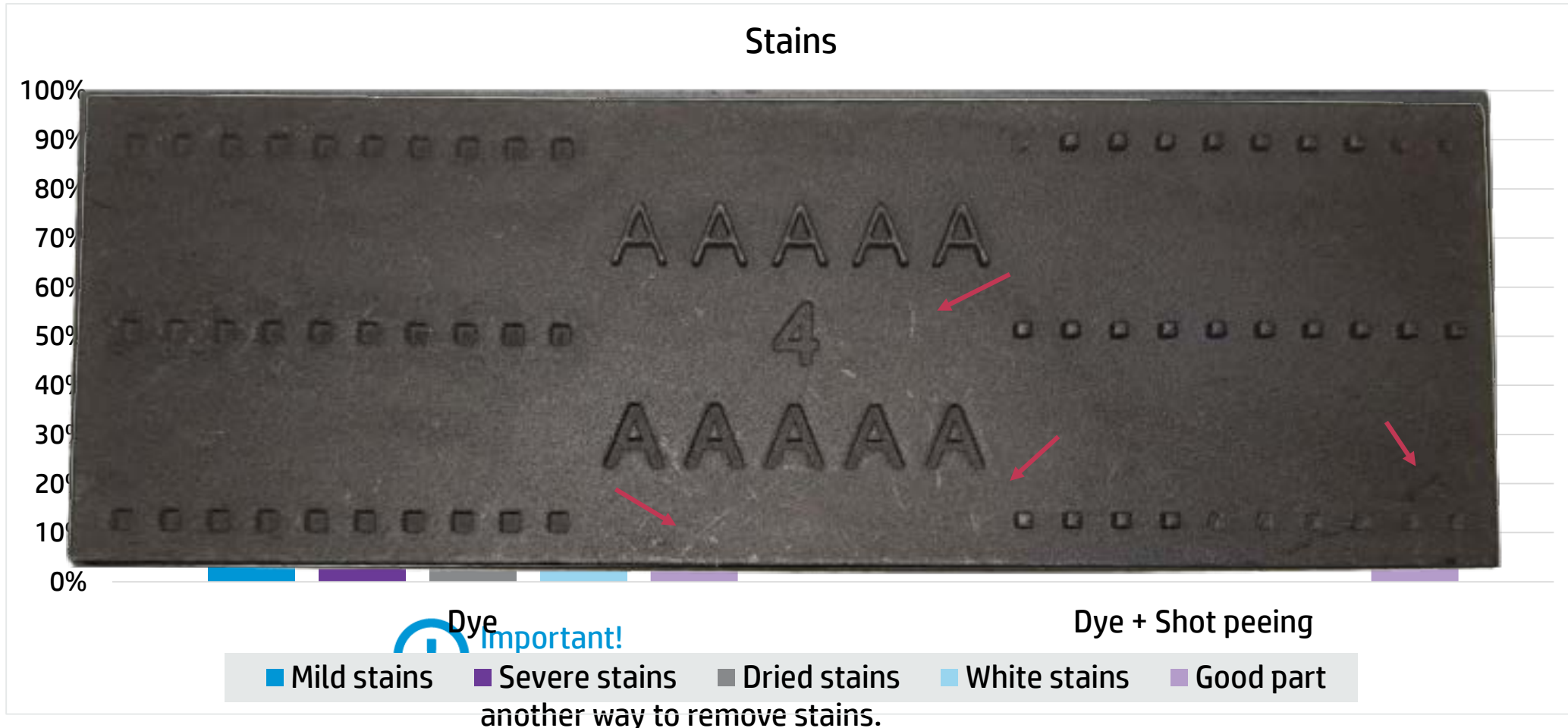


RIT black powder dye proline
Provided in powder state

Color Uniformity	Surface Roughness	Other Properties
Coloring		
Dimensional		

Dyeing

Stain & scratch removal. Workarounds after dyeing



Color Uniformity	Surface Roughness	Other Properties
Coloring		
Dimensional		

Graphite blasting

The easiest way to achieve color uniformity



Graphite blasting

Applications



Gears (lubrication of gears)



Visual prototypes



POST-PROCESSING		
Cleaning	Secondary post-processing	
	Black color Uniformity	Surface Roughness
	Coloring	Other Properties
	Dimensional	

Graphite blasting

Applications

Graphite will fade along time



Not recommended for final parts


Color Uniformity	Surface Roughness	Other Properties
Coloring		
Dimensional		

Graphite blasting


The easiest way to achieve color uniformity



Manual graphite blasting








\$3k - \$10k

Process preparation		Production workflow	
			
Create blend: 1. Weigh beads 2. Weigh graphite 3. Mix	Replace beads: (twice a day – 1 build) 1. Empty old beads 2. Fill in w/ new blend	Step 1: Bead blast with graphite	Step 2: Air blast
		1-5 min per part	
Process time	5 min	5 min	1-5 min
Operator time	5 min	5 min	5 sec
Machine time	5 min	5 min	1-5 min

Automatic graphite blasting



\$8k - \$15k

				
Create blend: 1. Weigh beads 2. Weigh graphite 3. Mix	Replace beads: (twice a day – 1 build) 1. Empty old beads 2. Fill in w/ new blend	Step 1: Place parts	Step 2: Bead blast with graphite + air blast	Step 3: Remove parts
		25 min per batch		
Process time	5 min	5 min	< 5 min	< 5 min
Operator time	5 min	5 min	< 5 min	< 5 min
Machine time	5 min	5 min	< 5 min	15 min

Coloring

POST-PROCESSING

Cleaning

Secondary post-processing



Part with powder



Raw part



Color Uniformity

- Dyeing
- Graphite blasting

Coloring

- Painting
- Dyeing

Dimensional

- Gluing, bonding, welding, sealing
- Drilling, tapping

Surface Roughness

- Vibratory finishing
- Coating/Painting
- Hand sanding
- Chemical treatment

Other Properties

- Wear resistance
- Conductivity
- Temperature resistance
- Mechanical strength
- Water tightness
- Chemical resistance



Final part

REQUIRED

OPTIONAL

Painting

Applications

POST-PROCESSING	
Cleaning	Secondary post-processing
	Color Uniformity
	Surface Roughness
	Coloring
	Other Properties
	Dimensional

✓
Consumer goods

✓
Industrial & automotive parts

✓
Visual models



Color Uniformity	Surface Roughness	Other Properties
Coloring	Dimensional	

Painting

Painting HP Jet Fusion 3D printed parts



Painting

Painting HP Jet Fusion 3D printed parts

Process preparation

Production workflow

 <p>Painting</p> <p>500\$</p>	Tools and paint preparation 		 <p>Step 1: Priming</p>	 <p>Step 2: Drying</p>	 <p>Step 3: Manual blasting</p>	<p>Step 4: Repeat steps 1-3 one or more times</p>	 <p>Step 5: Painting</p>	 <p>Step 6: Varnishing</p>	 <p>Step 7: Drying</p>
	<p>Process time</p>			90 min		3-8 hrs		35 min (optional)	
<p>Operator time</p>	15 min	15 min			30 min	...	15 min	15 min	20 min
<p>Machine time</p>	15 min	15 min			30 min	...	15 min	15 min	20 min

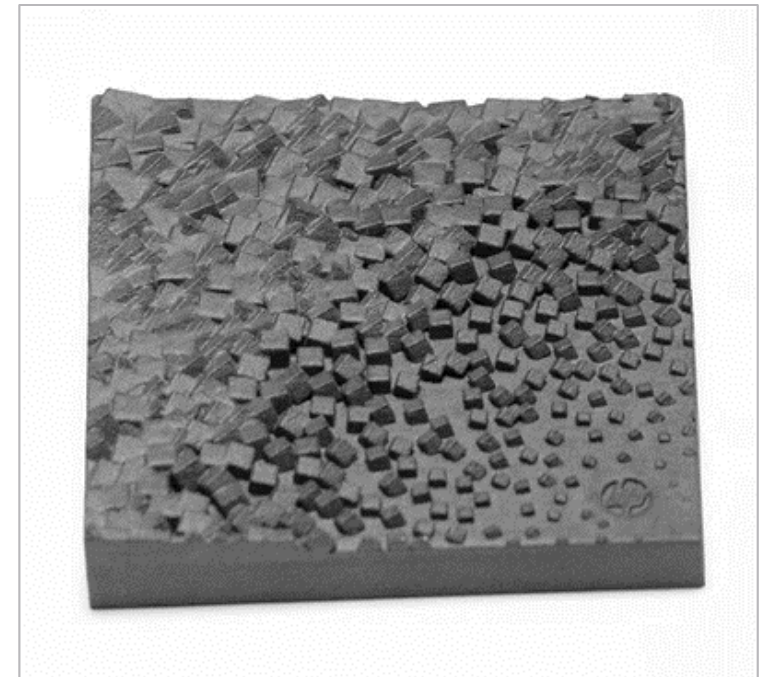
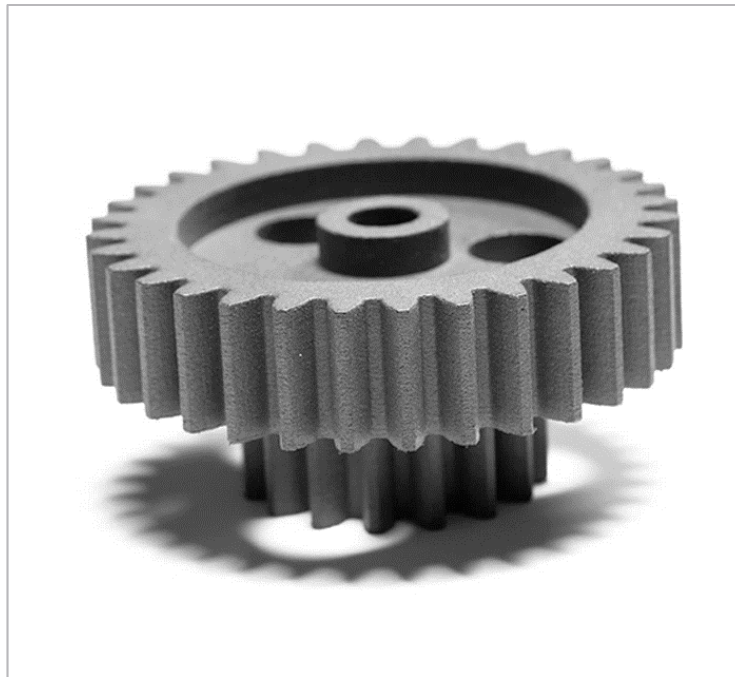
Advantages:

- HP Jet Fusion 3D parts can be painted in all colors.
- Water based & solvent based paints can be applied.
- Improved color uniformity and surface roughness
- Other properties can be achieved: UV resistance, scratch resistance, etc.

Color Uniformity	Surface Roughness	Other Properties
Coloring		
Dimensional		

Dyeing

But MJF parts can also be dyed with dark colors



Surface roughness

POST-PROCESSING

Cleaning

Secondary post-processing



Part with powder



Raw part

Color Uniformity

- Dyeing
- Graphite blasting

Coloring

- Painting
- Dyeing

Dimensional

- Gluing, bonding, welding, sealing
- Drilling, tapping

Surface Roughness

- Vibratory finishing
- Coating/Painting
- Hand sanding
- Chemical treatment

Other Properties

- Wear resistance
- Conductivity
- Temperature resistance
- Mechanical strength
- Water tightness
- Chemical resistance



Final part

REQUIRED

OPTIONAL

Vibratory finishing

Improving surface roughness



Vibratory finishing

Applications

POST-PROCESSING	
Cleaning	Secondary post-processing
	Color Uniformity
	Surface Roughness
	Coloring
	Other Properties
	Dimensional



Consumer goods



Tubes/pipes

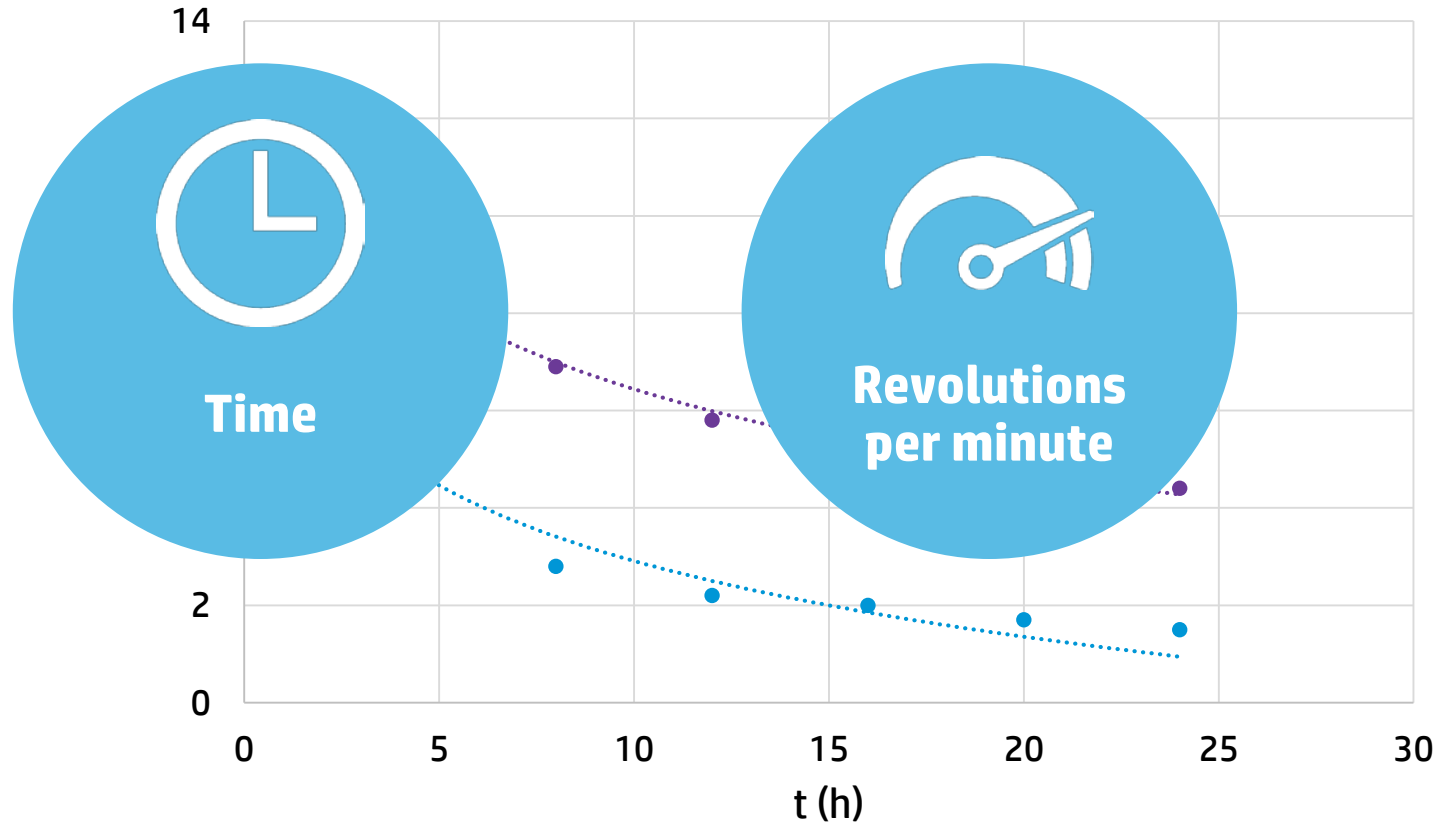


Color Uniformity	Surface Roughness	Other Properties
Coloring		
Dimensional		

Vibratory finishing

Improving surface roughness

Surface roughness along the tumbling process



Color Uniformity	Surface Roughness	Other Properties
Coloring		
Dimensional		

Vibratory finishing

Improving surface roughness

Process preparation

Production workflow

Vibratory Finishing



6-10k\$



Replace abrasive stones



Step 1: Place parts



Step 2: Vibratory finish



Step 3: Remove parts



Step 4: Dry

▶ Process time			3-24 hrs	2-3 hrs (optional)
👤 Operator time	15 min	5 min		5 min
⚙️ Machine time	15 min	5 min	3 - 24 hrs	5 min

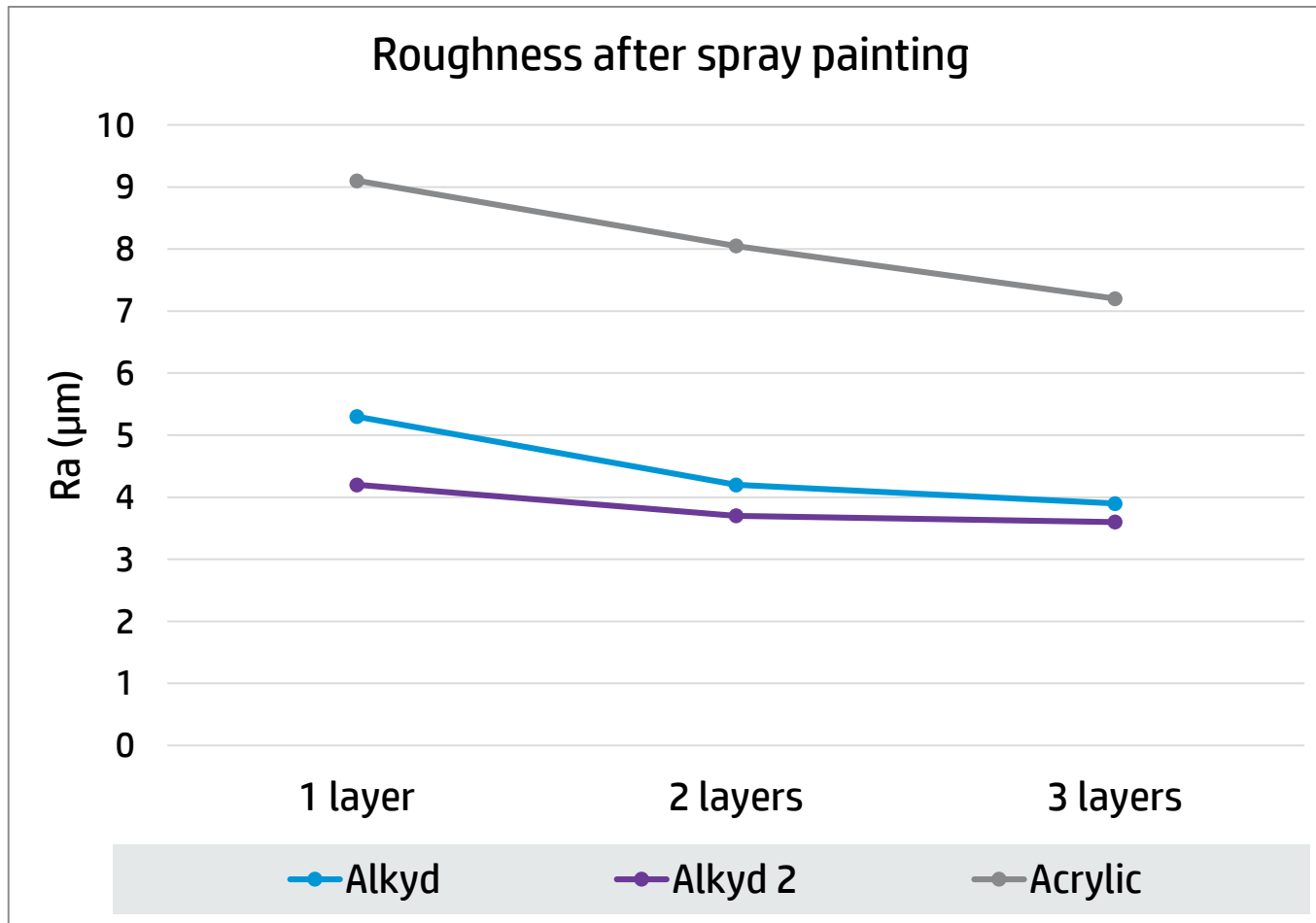
Advantages:

- Semi-automatic process
- Little operator time

Color Uniformity	Surface Roughness	Other Properties
Coloring		
Dimensional		

Painting

Also helps to improve surface roughness



Using a primer before painting gives you better results

Other smoothing options

Chemical polishing



Electroplating



Mechanical Polished



Electroplated after polishing



Dimensional

POST-PROCESSING

Cleaning



Part with powder

Cleaning

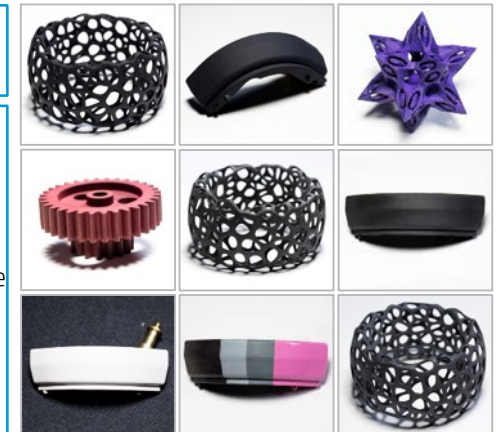
- Bead blasting
 - Glass beads
 - Shot peening



Raw part

Secondary post-processing

- Color Uniformity**
 - Dyeing - Graphite blasting
- Coloring**
 - Painting
 - Dyeing
- Dimensional**
 - Bonding, welding, sealing
 - Drilling, tapping
- Surface Roughness**
 - Vibratory finishing
 - Coating/Painting
 - Hand sanding
 - Chemical treatment
- Other Properties**
 - Wear resistance
 - Conductivity
 - Temperature resistance
 - Mechanical strength
 - Water tightness
 - Chemical resistance



Final part

REQUIRED

OPTIONAL



Bonding

Applications

POST-PROCESSING

Cleaning

Secondary post-processing

Color Uniformity

Surface Roughness

Coloring

Other Properties

Dimensional



Big parts



Bonding

POST-PROCESSING	
Cleaning	Secondary post-processing
Color Uniformity	Surface Roughness
Coloring	Other Properties
Dimensional	

Process preparation Production workflow



▶▶▶ Process time



Step 1: Design the bonding between parts

Part of the design process

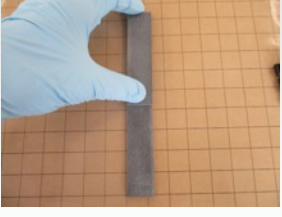


Step 2: Gluing preparation

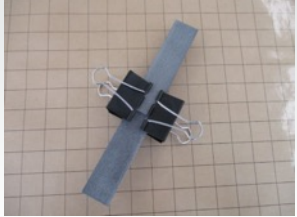


Step 3: Apply glue

5 min



Step 4: Join



Step 5: Dry

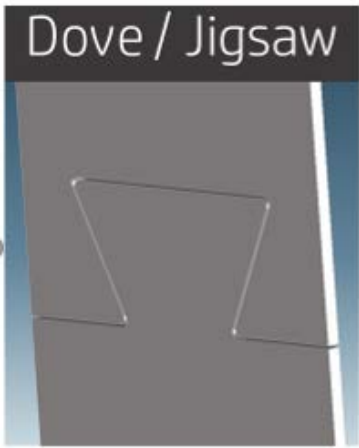
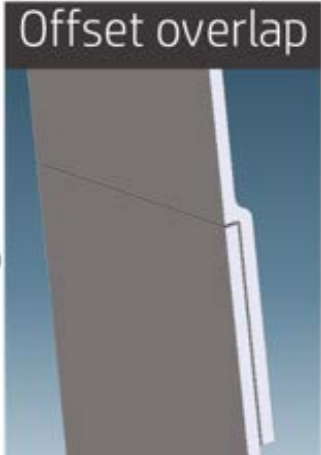

Adhesive dependent



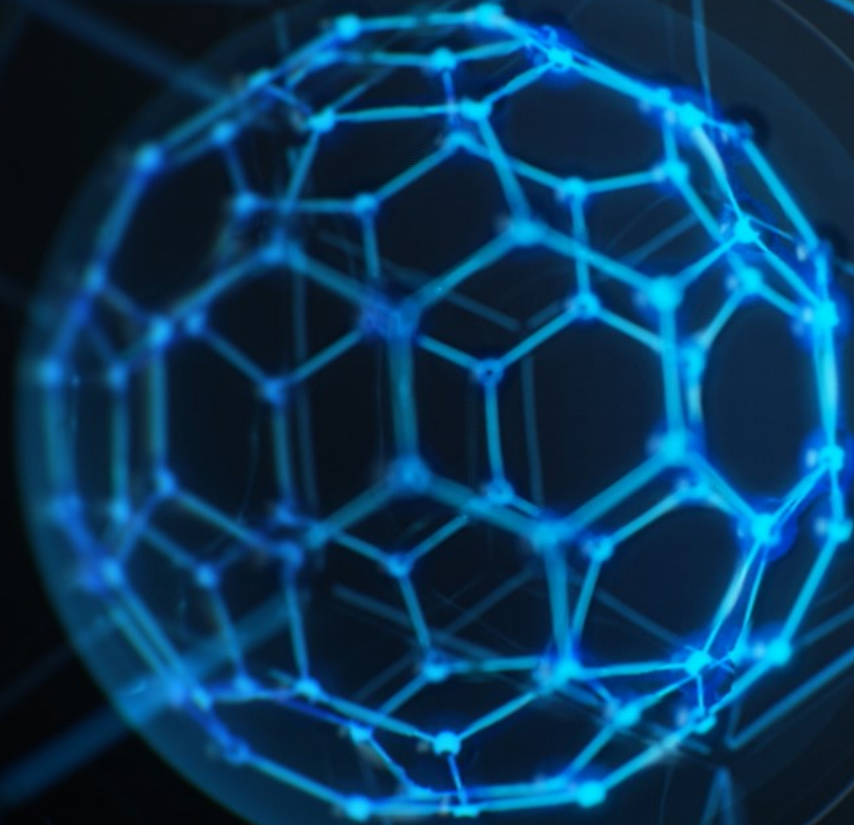
Bonding

Recommended design unions

POST-PROCESSING	
Cleaning	Secondary post-processing
Color Uniformity	Surface Roughness
Coloring	Other Properties
Dimensional	

Thickness < 1.7 mm		Thickness > 1.7mm
No geometry modification allowed	Geometry modification allowed	
<p>Dove / Jigsaw</p> 	<p>Offset overlap</p> 	<p>Overlap with multiple jigsaw</p> 

Questions and answers



Thank you

